17. Apple tree introduction and adaptation in the Tigray highlands

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1. General context of apple introduction in Tigray: livelihood and natural resource conservation

Tigray is a region of contrasts. In one hand, it is one of the origins for agriculture and on the other hand, it is characterized by conditions of widespread poverty and food insecurity. The majority of its population is engaged in agricultural production as a major means of livelihood though its production is very low to the extent of not meeting the consumption requirement of the households. The picture for the mid- to highlands of the region, in which the majority of the population lives and agriculture has been practiced for many centuries is severe. In those areas, rain-fed agriculture has expanded to marginal areas and farmers are forced to cultivate steeper slopes, often without the application of effective conservation measures. This has resulted in land degradation, declining agricultural productivity, malnutrition and health problems. Hence, the major challenge faced today in those highlands is learning how to make high returns or outputs of crops and livestock while still conserving the essential natural resources, which will be needed for the survival of future generations. Both the regional and national policies have been geared towards eradicating poverty by increasing income at household level. In this regard, high income generating enterprises are being sought for adoption by farmers. Particularly for the highlands, apple growing has been selected as one strategy in diversify the farming system and then improve family nutrition and income generation at household level, and mitigate land degradation through better land husbandry. To this effect, various government and non-government organizations, including Mekelle University have been involved in the introduction, adaptation and distribution of apple trees to individual farmers.

2. Project background

In the frame of an institutional collaboration project (MU-IUC) between different Flemish Universities in Belgium and Mekelle University (MU) in Ethiopia. The More Crop per Drop (MCPD) project is one of the six research projects financed. The objective of MCPD project is to promote integrated crop production management to small-scale farmers in the region to increase the productivity of staple food crops (tef – *Eragrostis tef*, barley – *Hordeum vulgare*, maize – *Zea mays*, etc.) and to diversify the cereal based farming system (introduction of adapted temperate fruit trees) in order to sustain food self-sufficiency and food security in the region. Apple introduction and adaptation, as one component of MCPD Project, had started through the introduction of some standard apple cultivars like 'Gala', 'Golden Delicious', 'Jonagold', 'Granny Smith' and 'Fuji' starting from 2003/2004. These cultivars were planted in Mekelle University campus (2200 m a.s.l.) and in May Zahla near Hagere Selam (2650 m a.s.l.). Since

then, research has been carried out to study the biophysical performance of these cultivars under the conditions of these highlands.

3. History of apple in Ethiopia

Though the exact period is not known, it is believed that apple trees were introduced into the tropical mountains of southwestern Ethiopia some 60 years ago by missionaries, and to Adigrat (Tigray) some 35 years ago (Ashebir *et al.*, 2009). Unfortunately, systematic observations have been carried out only once in the Ethiopian highlands at three climatically diverse sites on apple cultivars introduced in 1976 (Rice and Becker, 1990). In that trial, it was found that the trees performed well even at Bedessa, the lowest (1600 m.a.s.l.) and warmest site (14-18 °C min. and 28.5-32.5 °C max. temperature). However, it is only in the last five years that apple production has started to increase in volume. Reasonable efforts are underway by various government and non-government organizations to integrate apple fruit production into the existing cereal based farming system of the country. GTZ in Amhara, Tigray and Oromia, Kalihiwot in Chencha and MU-IUC are among the major actors in this regard.

4. Summary of research results

Generally, it is admitted that the major limiting factor for deciduous fruit production in Ethiopia is the lack of adequate winter-chilling in most of the country. The results reported here were obtained from trials designed to evaluate the effectiveness of spraying with hydrogen cyanamide (Dormex), with winter oil and hand defoliation at different doses and combinations, with the aim of improving and synchronizing the bud break and the blossoming period of standard apple cultivars. The results show that both chemicals are effective for dormancy release of the cultivars. Furthermore the effectiveness of hydrogen cyanamide in apple dormancy release is increased when combined with winter oil (Fig. 1). The defoliation treatment alone was not sufficient to break dormancy for the cultivars, with the notable exception of Jonagold and Fuji, suggesting the possibility of growing these two cultivars under farmers' management without use of chemicals. All in all, the research results indicate that it is possible to develop new apple production in the mountain region of Tigray, Ethiopia.

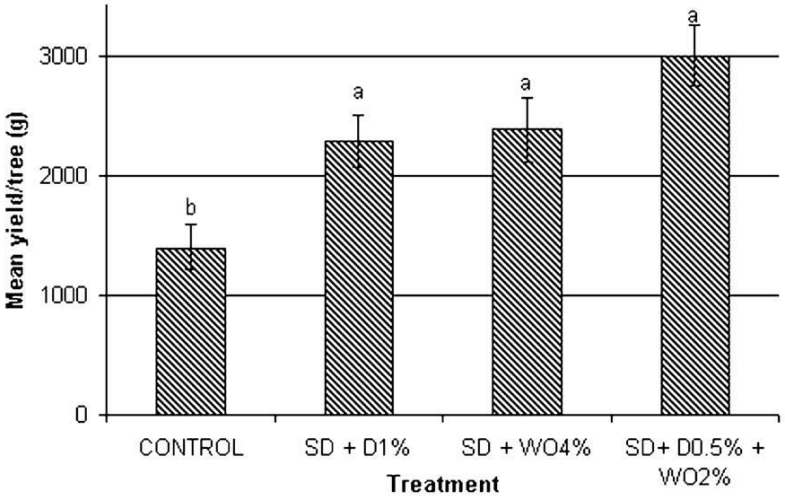

Figure 1. Effects of spraying chemicals on apple production at Hagere Selam and Mekelle University experimental sites. SD = Single defoliation; D0.5%, D1% and D2% = Dormex applications, and WO4% and WO2% winter oil applications (after Ashebir et al., 2009).

5. Apple extension

The research findings were promising and it has been found vital to transfer the technology to farmers. Hence, in the belief that, with proper cultural practices for apple trees under these highland conditions, farmers can increase their income, diversify their farming system and enrich their diet with essential minerals and vitamins, the project has started to multiply virus free planting materials of apple. Moreover, to reach farmers at the grass root level, a memorandum of understanding was signed between Mekelle University and the Tigray Bureau of Agriculture and Rural Development in 2007, including the plan to distribute 10,000 grafted apple trees every year for five years. In the previous years, the project had distributed more than 4000 grafted trees to farmers for free. Currently the project has more than 5,000 two-year-old grafted apple trees which are ready for distribution during January to February 2011.

Moreover, the apple research team at Mekelle University offers training and necessary technical advice regarding apple production and management to beneficiaries for free before the time of tree distribution and after the distribution. Some of the technical advices given were: the need to apply manure, bending of the lateral branches to induce flowering and expose the branches to light as the apple trees are sun loving plants, need of defoliating the leaves during their dormancy period, need of pruning of weak, damaged and excessive branches in a tree, and grafting techniques. So far under the programme 200 farmers and 40 extension staff have been trained in apple production. Small holder farm-households are the target groups supported with the main objective of contributing to improvement in income and overall living conditions of the farmers. Highland fruits are also contributing to the improvement in diet and health of the benefiting households, as well as to better management of land resources through integration of soil and water conservation activities.

Based on the advice and by applying their own agronomic practices some of the farmers were able to produce apple fruit for consumption and others sold some fruit in addition to their home consumption (see the case study and Table 1). A detailed inventory at the homesteads of four apple producing famers at May Shehi (some 10 km south of Hagere Selam) showed that each of them manages 30 to 306 apple trees (Table 1). Besides a lesser amount for home consumption and some that were destroyed by birds, the largest part of fruits harvested per year is sold at the market. However some trees had virtually no yield due to negligence, but also mismanagement of the trees. In addition, the farmers commented that apple trees make the area more attractive for bees, which supports the bee-keeping enterprise recently started by the youth. Moreover, apples also help to stabilize hill slopes and halt environmental degradation, even without resorting to expensive bench terracing, which has been the traditional system in the hill and mountain areas.

Case study - Mr. Gebrekiros Gebru is one of the farmers who has benefited from the apple production in May Shehi near Hagere Selam. He was asked to comment about the contribution of apple trees to his household economy. He said, “many families of my surrounding including myself have now started to benefit from apple production. I used to grow grains around my homestead, but have found that apples are much more lucrative. I have a total of 15 apple trees currently under production and another 291 apple trees that have not yet reached production. I was able to harvest 15 kg of fruits from some trees in one season. In the 2009-2010 cropping season alone, I sold 150 kg of apples at a price of 30 Birr per kg, my family ate 10 kg and few fruits were also eaten by birds. All in all, last year, I was able to satisfy for my home and able to

consume more apple fruits than any time before. On top of that, I was able to earn money by selling the fruits in Mekelle and Hagere Selam markets and have started saving." This suggest that farmers with 20 trees on their backyard can generate an income of at least 9000 Birr per annum, two times as much as the return from half a hectare of tef. "For all this thanks to MU-IUC and the Bureau of Agriculture at Hagere Selam, as I was given four apple trees in 2005. Now I use the land intensively and grow a total of 306 apple trees". Asked about his future plans, he answered: "I have the plan to plant more apple trees and increase my earnings as of the coming year. But I am worried about the problems of birds and powdery mildew."

Table 1. Number of apple trees and their harvest performances under farmers own managemnt at May Shehi in 2009-2010 cropping season. First few trees were planted in 2004-2005 and others have been added through the years.

Name	Total number of trees	Trees under production	Maximum harvest of a tree (kg)	Total fruits harvested (kg)	Apples consumed at home (kg)
Gebreselassie Gebru	30	15	15	100	5-10
Gebrekiros Gebru	306	15	20	150	10
Zebruabruk Kidan	60	15	10	40	5
Hiwot Gebregziabher	94	9	20	150	10

6. Conclusion

Generally, adaptation and growth performance of apple tree is encouraging in the Tigray highlands, with good survival rates. Farmers were able to successfully establish and manage plantations. Yields as high as 20 kg per tree were obtained from some trees. Such promising results suggest that by developing apple fruit trees in the highlands, the farmers' income can be substantially improved and erosion problems can be reduced. However, many technical problems are yet to be solved in order to provide answers to farmers who are interested to plant apples in the highlands. Appropriate ways of follow-up of apple trees planted in farmers backyards need to be explored. Moreover, all the production techniques, skills and knowledge required for appropriate and maximum production should also be introduced to the farming community together with supplying of the trees. Preparation of production manuals in such a way that it will be easily understandable by development agents is very crucial. Besides the elaboration of a manual in the local Tigrinya language, the provision of intensive trainings to development agents, subject matter specialists and farmers is crucial.

7. References

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